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14. ABSTRACT

Uncontrolled hemorrhage continues to be a leading cause of fatal injuries on the modern battlefield. Uncontrolled pelvic and inguinal bleeding is a leading preventable cause of death. This project is designed to study a new hemorrhage control device (Abdominal Aortic Tourniquet AAT) to control this kind of hemorrhage in a worst case scenario injury model (hemicorporectomy). Using a porcine model the AAT will be compared to conventional hemorrhage control using Combat Gauze and pressure dressing.

15. SUBJECT TERMS-

Nothing listed

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1. Introduction

Uncontrolled hemorrhage continues to be a leading cause of fatal injuries on the modern battlefield. Uncontrolled pelvic and inguinal bleeding is a leading preventable cause of death. The AAT is focused at this significant capability gap identified by the Institute of Surgical Research for care on the battlefield: how to address uncompressible hemorrhage that is not treatable by a tourniquet in the leg, groin, inguinal region and pelvis. This significant capability gap focuses on treatment for a class of preventable deaths not previously treatable. The solution to this problem must be stable, easy to apply and completely stop the loss of blood. The AAT™ is capable of this, and animal and human studies have demonstrated its safety and efficacy.

The AAT™ provides a rapid application of pneumatic compression to the aorta at the abdominal-pelvic junction to occlude blood flow in the common iliac and inguinal arteries. The target of the compression is the aortic bifurcation, which has historically been identified in relation to the umbilicus or the superior margin of the iliac crests. Compression at this level is effective and safe and regulated by the FDA for up to one hour of application. The device can be applied in about 45 seconds.

Difficult bleeds in the inguinal region continue to be a significant source of morbidity and mortality on the battlefield. Providing solutions for treating these wounds have direct life saving results. Wounds to the pelvis and inguinal region are now preventable causes of death.

The AAT™ is a circumferential device that utilizes a belt, windlass and pneumatic pressure to compress the aorta. The belt and windlass together greatly increase the stability of the compression. The pneumatic wedge shaped bladder provides focused pressure to squeeze the blood vessels passing through the lower abdomen and preventing flow. Prior research demonstrates the safety of up to one hour of application and its effectiveness in non-invasively cross-clamping the aorta or fully stopping all blood flow to the pelvis and lower extremities. In essence the AAT™ acts as a valve to figuratively 'turn the faucet off' and prevent the further flow of blood out of wounds below its application site.

This study will look at a "worst case scenario" utilizing a hemicorporectomy model and will compare the use of standard hemostatic gauze packing to the use of the AAT.

2. Body

The following milestones have been completed as listed in the proposal:
-The wounding device (Blade Lever Apparatus) was developed.
-The protocol received IAUCC and ACURO approval.
-A CRADA was drafted and a subcontract with Geneva Foundation established to allow us to complete the research at Eisenhower Army Medical Center.
-The research was initiated and an interim data analysis was done which showed statistical significance.
-The findings were presented at the 2014 Military Health System Research Symposium.

-An initial manuscript was written and submitted for publication. The initial manuscript was rejected by one journal and the reviewer comments have been addressed. The article is currently being resubmitted to another journal.

PRODUCTS: None

ISSUES: As the study was initiated delays occurred due to a temporary shortage of Veterinarians at Georgia Regents University (GRU). The research was to be completed at Fort Gordon, which required going through a third party not-for-profit foundation. These delays necessitated a no cost extension on the project. Despite the initial delay, the primary outcomes of the study were met early. Our intent was to expand the study to include safety studies as related to the development of reperfusion injury after application of the device. As we amended the protocol a new CRADA was required to be put into place. This occurred at the time a change of Veterinarians at Fort Gordon occurred, which created substantial delay. The CRADA was put in place, however we ran out of time to reasonably complete the administrative preparation to complete the additional study.

Progress Summary

Quarter 1:	-Kick off meeting with TATRC -The wounding model has been developed and tested using dead pigs -Investigators have had periodic meetings -Protocol 90% complete and will be submitted to IACUC early second quarter
Quarter 2:	-Protocol completed and submitted to IACUC with one revision -Coordination between GRU and Fort Gordon investigators
Quarter 3:	-Protocol approved by IACUC and ACURO
Quarter 4:	-No Cost Extension submitted. CRADA in place. Subcontract with Geneva Foundation drafted
Quarter 5:	-Animal Research Initiated
Quarter 6:	-A total of 6 pigs were studied and all three animals treated with the AAT survived and all three animals treated with Combat Gauze died. The primary endpoint and all secondary endpoints reached statistical significance. Abstracts were submitted to the Military Health Systems Research Symposium and the American College of Emergency Physicians annual meetings.

Quarter 7: -Abstract accepted for a poster presentation at the Military Health System Research Symposium in Aug. 2014. No cost extension submitted for project.

Quarter 8: -Abstract presented at MHSRS Aug. 2014. Manuscript drafted. An amendment to the protocol has been presented to the IACUC to further study the safety of the AAT.

Quarters 9 – 12 - CRADA was revised and approved. New veterinarian staff in place at DDEAMC Clinical Investigation.

3. Key Research Accomplishments

The study wounding protocol was finalized. A hemi-corporectomy model was found to be the most reproducible. A total of 6 animals were studied with three in the AAT group and three in the Combat Gauze group. An interim analysis was completed and the primary and secondary endpoints were both statistically significant. The research findings were presented as a poster at the MHSRS meeting Aug. 2014. Manuscript has been written and revised and is in the process for resubmission.

4. Reportable Outcome

The following abstract was presented at the 2014 Military Health Systems Research Symposium:

Title: The Use of the Abdominal Aortic and Junctional Tourniquet (AAJT) Versus Combat Gauze (CG) in a Porcine Hemicorporectomy Model

Background: Junctional hemorrhage is a leading cause of combat related deaths and vascular injury proximal to the inguinal ligament represents a substantial number of these injuries. The AAJT is designed to arrest blood flow at the level of the aortic bifurcation. We theorize that the AAJT can control pelvic vascular injuries that are not amenable to control with conventional hemostatic devices.

Methods: A total of 6 pigs were studied. All pigs were wounded utilizing a "Blade Lever Device" to create a hemicorporetomy. The device creates a wound through the bilateral femoral heads, extends through the pelvis, and transects the internal and external iliac vessels. Following wounding, in 3 pigs a preplaced AAT was inflated and the wound covered with 2 rolls of Kerlix gauze. In the other 3 pigs, no AAT was utilized. The wounds in these animals were immediately covered with 2 packs of CG followed by direct pressure for 3 minutes (per manufacturers instructions). Following 3 minutes, the CG was backed with 2 rolls of Kerlix gauze. An elastic bandage (Israeli Dressing) was placed over the Kerlix for both the AAJT and CG animals. Subjects were monitored and data collected for 60 minutes.

Results: Initial MAP's were similar. 60 minute survival: AAJT = 100%, CG = 0 % (p=0.025). Mean 5 min blood loss: 525cc AAJT and 1323 CG (p<0.023). Mean 5 min MAP: 77 AAJT and 18 CG (p<0.023). Mean 60 min MAP: 73 AAJT and N/A CG. Mean time to hemostasis: 30 sec. AAJT and 1980 sec. CG (p<0.023).

Conclusion: In this severe pelvic hemorrhage model the AAJT was superior in all measures compared to conventional wound packing with Combat Gauze.

The following abstract was submitted but rejected. We plan to integrate these data into the full manuscript when submitted.

Title: Airway Pressure Changes Following the Application of the Abdominal Aortic and Junctional Tourniquet (AAJT)

Background: The AAJT is a novel hemorrhage control device. The device can be utilized to control hemorrhage in the axilla, groin and pelvis by placing the device over the axilla, groin or umbilicus respectively. Concern has been raised that placement of the device over the umbilicus may increase the intra-abdominal pressure and this would be reflected to the diaphragm and have a negative impact on casualty respiration.

Methods: Six 45-55 Kg pigs were intubated, paralyzed and placed under general anesthesia. The peak airway pressure was measured without the AAJT in place and inflated. The AAJT was then placed and inflated and the peak airway pressure was then re-measured.

Results: The mean pre-AAJT peak airway pressure was 19.17 cm H2O (Std. Deviation 1.84). The mean post-AAJT peak airway pressure was 25.67 (Std. Deviation 3.62). This difference was statistically significant (p<0.007).

Conclusion: The application of the AAJT increases the peak airway pressure of intubated pigs. The mean increase in pressure was 6.5 cm H2O. The clinical significance of this elevation in airway pressure is unknown at this time.

5. Conclusion

The data from this project demonstrates the superiority of the AAT to the use of conventional hemostatic agents in this severe pelvic injury model. These data demonstrate the value of this device for severe pelvic injuries where standard treatment is inadequate. As a hemicorporectomy model was utilized other junctional devices such as the CROC or Junctional Emergency Treatment Tool (JETT) could not be utilized due to the disruption of the anatomy in the placement location of those devices. Future studies should occur looking at the potential for reperfusion injury with one hour of device application as directed by the product directions for use.

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7. Appendices: None

8. Supporting Data: None